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Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Amendment of Parts 2 and 25 of the	)	
Commission's Rules To Allocate Spectrum in	)	RM No. _____
the 14-14.5 GHz Band to the Aeronautical	)	
Mobile-Satellite Service ("AMSS") and To	)	
Adopt Licensing and Service Rules for AMSS	)	
Operations in the Ku-Band	)	

To: The Commission

PETITION FOR RULEMAKING

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SUMMARY

The Boeing Company ("Boeing"), the leading proponent of real-time, two-way broadband connectivity to aircraft passengers and crew, respectfully requests that the Commission promptly initiate a rulemaking proceeding to amend Parts 2 and 25 of its Rules to allocate the Aeronautical Mobile-Satellite Service ("AMSS") in the 14-14.5 GHz band on a secondary basis, and to adopt licensing and service rules for AMSS operations in the Ku-band. Such action is necessary to implement domestically the decision of the International Telecommunication Union's ("ITU") 2003 World Radiocommunication Conference ("WRC-03") to add this allocation to the international Radio Regulations, and to facilitate the global licensing of the Connexion by Boeing[SM] system. The United States was the leading proponent of the international AMSS allocation and supported the ITU-R preparatory work on this agenda item leading up to WRC-03, including the development of Recommendation ITU-R M.1643. Thus, implementing the AMSS allocation domestically is the logical next step in the United States' successful international allocation efforts.

Although Boeing is authorized to provide transmit-receive AMSS within the United States pursuant to a blanket aircraft earth station license, these operations have been authorized only on an unprotected, non-harmful interference basis as a "non-conforming use" because the U.S. Table of Frequency Allocations does not include a Ku-band AMSS allocation. Now that WRC-03 has adopted an allocation change to permit secondary AMSS operations in the 14-14.5 GHz band, the Commission should adopt this allocation domestically and authorize AMSS operations in the band on a secondary basis.

The Commission also should adopt comprehensive technical, operational and licensing rules to govern AMSS provided on aircraft operating within the United States, and on U.S.-

registered aircraft operating both domestically and internationally. In this connection, much of the technical and regulatory work necessary to develop these rules has already been done in the context of reviewing Boeing's prior transmit-receive applications; and in developing within the ITU study group process Recommendation ITU-R M.1643, which was adopted by the 2003 Radiocommunication Assembly. This ITU-R Recommendation outlines the technical and operational guidelines for AMSS operations in the 14-14.5 GHz band, including "essential requirements" related to the protection of co-frequency Fixed-Satellite Service and Fixed Service networks, and for sharing with the Radio Astronomy and Space Research Services. Thus, Recommendation ITU-R M.1643 provides an important foundation for developing licensing and service rules governing Ku-band AMSS operations.

The timely adoption of a Ku-band AMSS allocation and the proposed licensing and service rules will facilitate the provision of innovative aeronautical broadband services to commercial airlines, U.S. government agencies and private aircraft customers. Aircraft passengers will enjoy the convenience of high-speed Internet access and interactive entertainment options; airlines and crew members will have access to broadband service capabilities that will enhance the efficiency of aircraft operations; and U.S. government personnel and decision makers will have access to real-time broadband services aboard AMSS-equipped government aircraft, enabling them to communicate more effectively and make timely and informed decisions affecting national security, foreign policy and other matters. Accordingly, prompt initiation of the requested rulemaking proceeding would strongly serve the public interest.

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To: The Commission

PETITION FOR RULEMAKING

The Boeing Company ("Boeing"), by its attorneys and pursuant to Section 1.401 of the Commission's Rules, 47 C.F.R. § 1.401, respectfully requests that the Commission promptly initiate a rulemaking proceeding to amend Parts 2 and 25 of its Rules to allocate the Aeronautical Mobile-Satellite Service ("AMSS") in the 14-14.5 GHz band on a secondary basis, and to adopt licensing and service rules for AMSS operations in the Ku-band. Adoption of the proposed allocation and rules would implement domestically the decision of the International Telecommunication Union's ("ITU") 2003 World Radiocommunication Conference ("WRC-03") to add this allocation to the international Radio Regulations.[1] The timely adoption of these rules also will facilitate the provision of innovative aeronautical broadband services in the United States and around the world to commercial airlines, U.S. government agencies and other executive aircraft customers, and thus would strongly serve the public interest.

[1] Pursuant to Resolution [COM4/25] (WRC-03) and No. 59.8 of the revised international Radio Regulations, the international AMSS allocation became provisionally effective as of July 5, 2003.

I. INTRODUCTION

Boeing is the leading proponent of real-time, two-way broadband connectivity (*e.g.*, Internet access, e-mail connectivity, e-commerce, etc.) for passengers and crew of commercial, government and executive aircraft through its Connexion by Boeing[SM] ("Connexion") service. Boeing has worked closely with the Commission over the last several years to obtain authorizations for AMSS aircraft earth station ("AES") operations in Ku-band Fixed-Satellite Service ("FSS") spectrum within the United States and in international airspace; to develop technical guidelines for AES operations within the ITU Radiocommunication Sector ("ITU-R") Study Group process; and to secure at WRC-03 a global spectrum allocation for AMSS on a secondary basis in the 14-14.5 GHz band. In this regard, the International Bureau recently reported on the U.S. Delegation's successes at WRC-03 in expanding choices for U.S. consumers by securing spectrum for such services as "broadband-in-flight, which provides high-speed Internet access to airline passengers."[2] Indeed, the AMSS agenda item for WRC-03 was viewed by the United States as one of the top priorities at the Conference.[3]

Connexion has already achieved significant commercial progress in launching this new broadband service. Lufthansa and Boeing have signed a definitive service agreement that makes this European airline carrier the launch customer for the Connexion service. This agreement envisions the installation of Connexion service on a fleet of approximately 80 long-haul aircraft beginning in early 2004. A second definitive service

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[2] FCC News Release, *International Bureau Reports on Success of the 2003 World Radiocommunication Conference* (rel. July 10, 2003).

[3] *See WRC Proposal on In-Flight Satellite Internet Gains at Geneva*, Satellite Week (June 16, 2003); *WRC Proposal on In-Flight Satellite Internet Moves Forward,* Communications Daily (June 11, 2003); *see also U.S. Faces WRC Challenges*, Satellite News (June 23, 2003); *ITU Tackles Challenges*, Interspace (June 18, 2003).

agreement has also recently been announced with Scandinavian Airlines System ("SAS") to equip eleven long-haul aircraft also beginning in early 2004, with options for expansion. In addition, British Airways has recently completed demonstrations of the Connexion service on its aircraft, and Japan Airlines ("JAL") has announced its intent[4] to install the service on long-range aircraft. The service is also available to the executive services market in the Unites States, including operators of private and government aircraft.

Given current AMSS operations and planned expansion of Connexion services, including on commercial flights to and from the United States, Boeing has a direct and compelling interest in the allocation of AMSS spectrum domestically and the establishment of licensing and service rules. Specifically, adoption of the AMSS allocation and proposed rules will afford Boeing and other potential providers the regulatory certainty necessary to fully implement their business plans, rather than operating without uniform technical guidelines or regulatory protection as a non-conforming use. Such certainty would not only facilitate the introduction of new AMSS systems and services, thereby promoting competition; but also would promote the penetration of AMSS into this untapped market by enhancing the confidence of early adopters of this new technology, thereby accelerating the benefits of this innovative service to consumers in the United States and around the world.

[4] In 2002, JAL and Connexion executed a Memorandum of Understanding outlining the parties' intent to reach an agreement for the installation of Connexion service on JAL aircraft.

A. U.S. and Foreign Licensing Of AMSS in the Ku-Band

On December 21, 2001, the Commission licensed Boeing to operate up to 800 technically identical transmit-receive AESs with phased array antennas to provide AMSS in Ku-band frequencies.[5] The Commission authorized Boeing's AMSS operations in the 11.7-12.2 GHz (downlink) and 14-14.5 GHz (uplink) bands, including the airspace above U.S. territorial waters, subject to certain conditions.[6] Boeing initially was authorized to provide AMSS using the Telstar 6 satellite at 93° W.L., and the Commission subsequently modified Boeing's license to add the Americom 4 ("AMC-4") satellite at 101° W.L. as an authorized point of communication, subject to the same operational conditions set forth in the *Transmit-Receive Order.*[7]

Boeing also has experimental authority from the Commission to operate up to ten phased array AESs over international waters until April 2004 to conduct experiments, perform limited

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[5] *See* Radio Station Authorization, Call Sign E000723, File No. SES-MOD-20020308-00429; *see also The Boeing Company,* Order and Authorization, 16 FCC Rcd. 22645 (Int'l Bur./OET 2001) ("*Transmit-Receive Order*"). The order recognized that a rulemaking proceeding to modify the U.S. Table of Frequency Allocations may be warranted following adoption of an international secondary allocation for AMSS in the 14 GHz band. *Id.* at n.60. The *Transmit-Receive Order* expanded Boeing's previously licensed receive-only AMSS service by adding transmit-receive authority. *See The Boeing Company*, Order and Authorization, 16 FCC Rcd. 5864 (Int'l Bur./OET 2001).

[6] *See generally Transmit-Receive Order*; *see also id.*, ¶ 19.

[7] *See* Radio Station Authorization, Call Sign E000723, File No. SES-MOD-20020308-00429 (granted Aug. 16, 2002). In addition, Boeing recently filed an application to modify its transmit-receive license to substitute 675 reflector antenna AESs for a like number of AESs with phased array antennas. *See* Boeing Application to Modify Blanket Authorization to Operate up to Eight Hundred Technically Identical Transmit and Receive Mobile Earth Stations Aboard Aircraft in the 11.7-12.2 and 14.0-14.5 GHz Frequency Bands, File No. SES-MOD-20030512-00639 (filed May 12, 2003). That application has been placed on Public Notice and remains pending before the Commission. *See* Public Notice, Report No. SES-00503 (June 4, 2003).

test marketing and provide service under contract with the U.S. government.[8] In addition, Boeing has received either temporary or permanent authorizations from approximately twenty other countries to provide AMSS in foreign airspace.[9] Although the Commission and foreign administrations found substantial public interest benefits in authorizing Connexion services, they imposed certain restrictions on Boeing's operations because there was not yet an international AMSS allocation in the Ku-band spectrum in which Boeing sought to operate.[10]

B. Recent 2003 Radiocommunication Assembly and WRC-03 Actions Establish the International Regulatory Framework for AMSS Operations and Licensing in the Ku-Band

Working closely with Boeing, the Commission and other U.S. government departments have championed the efforts to secure a global allocation for AMSS on a secondary basis in the 14-14.5 GHz band, and to develop the technical guidelines necessary to facilitate international AES operations and licensing in the Ku-band. These efforts have culminated in WRC-03's approval of a global secondary AMSS spectrum allocation in the 14-14.5 GHz band, and the 2003 Radiocommunication Assembly's approval of Recommendation ITU-R M.1643 on the "Technical and Operational Requirements for Aircraft Earth Stations of Aeronautical Mobile-

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[8] *See* Experimental Authorization, Call Sign WC2XVE, File No. 0032-EX-ML-2002. Boeing also has filed a modification application to add 10 reflector antenna AESs to its experimental authorization. *See* File No. 0038-EX-ML-2003 (submitted June 13, 2003).

[9] These include authorizations from Germany, the United Kingdom, Canada, France, Iceland, Greenland, Ireland, Belgium, Denmark, Norway, Switzerland, Poland, Finland, Sweden, Czech Republic, Italy, Greenland, Estonia, Austria and the Faroe Islands.

[10] For example, like the foreign authorizations granted prior to WRC-03, the Commission required Boeing to provide AMSS service on an unprotected, non-harmful interference basis as a "non-conforming" use of spectrum. In addition, all but one of the foreign authorizations were granted on a provisional basis with the opportunity to apply for more permanent authority upon the allocation of Ku-band AMSS spectrum at WRC-03.

Satellite Service Including Those Using Fixed-Satellite Service Network Transponders in the Band 14-14.5 GHz (Earth-to-space)."[11]

Acting under Resolution 216 (Rev.WRC-2000) (inviting study of secondary AMSS operations in the 14-14.5 GHz band) and WRC-03 Agenda Item 1.11 (the AMSS allocation item), WRC-03 adopted the AMSS allocation by removing the exclusion against aeronautical mobile-satellite in the existing secondary Mobile-Satellite Service ("MSS") (Earth-to-space) allocation.[12] The new allocation is accompanied by footnote No. 5.AA13, which recognizes that AES operating in the AMSS in the 14-14.5 GHz band may communicate with space stations of the FSS. Country footnotes Nos. 5.BB02, 5.BB03, and 5.BB04 also were added by a few countries (none from ITU Region 2) to explicitly require the protection of the primary Fixed Service ("FS") operations in their territories, a requirement which is already inherent in the secondary status of the AMSS allocation. Another country footnote, No. 5.BB01, provides for the protection for secondary Radio Astronomy Service ("RAS") operations in those countries.[13]

Recommendation ITU-R M.1643 provides technical and operational guidelines for AES operations in the 14-14.5 GHz band, including "essential requirements" relating to the protection of co-frequency FSS and FS networks, and for sharing with the RAS and Space Research Service

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[11] Recommendation ITU-R M.1643 is included as Attachment 1 hereto.

[12] *See* Provisional Final Acts of WRC-03, Article 5.

[13] Other WRC-03 actions related to the AMSS allocation included: a modification to Radio Regulation No. 9.17A to provide for the coordination of typical earth stations (such as AESs) with specific earth stations, thereby providing protection to Space Research Service stations; a commitment statement regarding AESs and consequential changes to Appendix 4 of the international Radio Regulations regarding notification of AES networks; and suppression of Resolution 216 (Rev.WRC-2000).

("SRS").[14] The Recommendation includes AES power flux-density ("p.f.d.") levels that ITU-R studies establish are sufficient, with some margin, to protect these services from harmful interference. The Recommendation was developed by the ITU-R, with active participation by the United States, and was approved by the 2003 Radiocommunication Assembly just prior to WRC-03. Along with the Commission's existing rules governing Ku-band satellite services and earth station licensing, Recommendation ITU-R M.1643 provides a technical basis upon which to develop licensing and service rules for U.S.-licensed Ku-band AMSS operations.

II. THE COMMISSION SHOULD AMEND THE U.S. TABLE OF FREQUENCY ALLOCATIONS TO INCLUDE A SECONDARY AMSS ALLOCATION IN THE 14-14.5 GHZ BAND

In light of the actions taken by WRC-03 and the 2003 Radiocommunication Assembly, and the substantial public interest benefits associated with authorizing AMSS in the Ku-band, the Commission should amend the U.S. Table of Frequency Allocations, 47 C.F.R. § 2.106, to allocate the 14-14.5 GHz band for AMSS use on a secondary basis. This allocation change can be accomplished by broadening the existing secondary "Land mobile-satellite (Earth-to-space)" allocations in the Non-Federal Government column of the U.S. Table throughout the 14-14.5 GHz band simply by removing the word "Land."[15] This action would align the domestic table with the changes to the International Table of Frequency Allocations adopted by WRC-03. Alternatively, the Commission could add a secondary "Aeronautical mobile-satellite" allocation to the Non-Federal Government column of the U.S. Table. Naturally, the Commission should

[14] *See* Recommendation ITU-R M.1643 at Annex 1. This Recommendation also contains a methodology for deriving an equivalent e.i.r.p. mask from a p.f.d. mask to ensure protection of and sharing with co-frequency services. *See id.* at Annex 2.

[15] Although this approach would align the U.S. and International Tables of Frequency Allocations, a generic MSS allocation could permit the implementation of new MSS services other than AMSS.

also take this opportunity to update the International Table to remove "except aeronautical mobile-satellite" from the existing secondary "Mobile-satellite (Earth-to-space)" allocations for the 14-14.5 GHz band to reflect the global allocation change made at WRC-03.

A. Implementation of a Domestic Secondary AMSS Allocation in the 14-14.5 GHz Band Is Necessary To Implement Domestically the Final Acts of WRC-03 and To Serve the Public Interest

The proposed revisions to the U.S. Table of Frequency Allocations outlined above are necessary to implement domestically the decisions reached at WRC-03 to permit secondary AMSS operations in the 14-14.5 GHz band, including Resolution [COM4/25], which brings the AMSS allocation into provisional effect immediately following the conclusion of WRC-03. The United States was the leading proponent of the international AMSS allocation and supported the ITU-R preparatory work on this agenda item leading up to WRC-03, including the development of Recommendation ITU-R M.1643. Thus, implementing the AMSS allocation domestically is the logical next step in the United States' successful international allocation efforts.

In addition, adopting a secondary AMSS allocation in the 14-14.5 GHz band would serve the public interest. The aeronautical broadband services that will be provided under the proposed AMSS allocation will extend to aircraft passengers the convenience of high-speed Internet access and interactive entertainment options. Airlines and crew members will have access to broadband communications capabilities that will enhance the efficiency of aircraft operations (*e.g.*, monitoring of equipment and supply inventories) and reduce turn-around times at the gate, will provide dynamic weather maps and related information, and will permit live security monitoring, telemedicine and other crew information applications. In addition, U.S. government personnel and decision makers have shown continuing and growing interest in access to real-time broadband communications services aboard AMSS-equipped government

aircraft, enabling them to communicate more effectively and make timely and informed decisions affecting national security, foreign policy and other important U.S. government matters.[16]

Adopting an AMSS spectrum allocation domestically would also provide additional regulatory certainty in the United States and internationally for these innovative satellite services. The proposed spectrum allocation (along with AMSS licensing and service rules) would normalize the licensing of Ku-band AMSS operations, rather than relegating these important services to an unprotected, non-interference status as a "non-conforming use." In addition, such rules would confirm the required protection of primary and other incumbent users of the 14-14.5 GHz band.

Moreover, adding a secondary AMSS allocation to the 14-14.5 GHz band would further many of the Commission's spectrum policy objectives, including maximizing the flexible use of spectrum, defining AMSS spectrum rights and responsibilities, promoting spectrum efficiency and improving access to spectrum by services with mutually compatible technical characteristics.[17] Thus, adopting the proposed AMSS allocation will further the Commission's spectrum policy goals.

B. The Proposed Allocation Can Be Implemented Without Interfering with Other 14-14.5 GHz Band Services

The addition of an AMSS allocation to the U.S. Table of Frequency Allocations can be made without adversely affecting other services in the 14 GHz band. The U.S. Table of Frequency Allocations includes a primary FSS allocation (Earth-to-space) in the 14-14.5 GHz

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[16] *See* Section V, *infra*.

[17] *See* Spectrum Policy Task Force Report, ET Docket 02-135 (Nov. 2002) at 15-22.

band.[18] This Ku-band FSS uplink spectrum is used to provide a variety of services, including very small aperture terminal ("VSAT") services that are widely deployed throughout the United States.[19] The U.S. Table also includes a primary allocation to the Radio Navigation Service in the 14-14.2 GHz band,[20] and provides for the protection of RAS operations in the 14.47-14.5 GHz band.[21] In addition, the U.S. Table includes secondary allocations in the 14-14.5 GHz band, such as mobile (except aeronautical mobile), SRS, and government-only terrestrial fixed and mobile services.[22]

The Conference Preparatory Meeting ("CPM") Report to WRC-03 concluded that, based on the results of extensive studies conducted within the ITU-R, "it has been demonstrated that it is feasible for appropriately designed AMSS networks to be operated on a secondary basis in the band 14-14.5 GHz without causing harmful interference to primary services in the band" and "[a]dditional studies have shown the feasibility of AMSS sharing with services employing

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[18] *See* 47 C.F.R. § 2.106.

[19] *See id.* Some operations in the 14 GHz band have also been authorized in the United States on a secondary basis for LMSS and, on a non-conforming basis, for the Maritime Mobile-Satellite Service ("MMSS"). *See Transmit-Receive Order,* at ¶ 8. Because these LMSS and MMSS operations use FSS satellite transponders, they will benefit equally from the protection afforded by AMSS systems to FSS satellite networks in these bands.

[20] Boeing understands that there are no radio navigation operations in this band. *See Transmit-Receive Order,* at ¶ 7.

[21] *See* 47 C.F.R. § 2.106; *see also id.* at n. 5.149 and n. US203.

[22] The Local Television Transmission Service ("LTTS") is authorized to use the 14.2-14.4 GHz band pursuant to a domestic secondary allocation to mobile services; however, the Commission's licensing database contains only about twenty LTTS licensees for this band, and in all cases, these licenses also include authorization to operate in other bands pursuant to Section 101.803 of the Commission's Rules.

secondary allocations in the band."[23] These results were carried forward to the 2003 Radiocommunication Assembly, which approved Recommendation ITU-R M.1643.

C. The Commission Need Not Alter the Existing Allocations in the 11.7-12.2 GHz Band To Permit Corresponding AMSS Downlink Operations

There is no global or domestic downlink band paired with the 14 GHz MSS uplink band. Therefore, similar to existing Ku-band MSS operations, downlink operations in the United States for the 14 GHz AMSS uplink would occur in the 11.7-12.2 GHz band, an FSS band with no MSS allocation. Boeing proposes that AMSS licensees continue to be authorized to operate in this band on a non-conforming use basis.[24] As a result, the Commission need not alter the existing allocations in the 11.7-12.2 GHz band to accommodate AMSS.

The Commission may authorize AMSS downlink operations in the 11.7-12.2 GHz band as a non-conforming use for several reasons. First, currently proposed AMSS operations utilize standard Ku-band FSS satellite transponders to provide communications services, which operate in accordance with Part 25 of the Commission's Rules and/or are coordinated with adjacent satellite operators to avoid causing harmful interference. From an interference perspective, there is no difference between an FSS transponder used for FSS downlink operations and the same FSS transponder used for AMSS downlink operations. As a result, AMSS downlinks in the

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[23] *See* WRC-03 Document No. 3, CPM Report to 2003 World Radiocommunication Conference at 2.4.2.

[24] Thus, AMSS downlink operations (i) must not cause harmful interference into any authorized station operating in the 11.7-12.2 GHz band in compliance with the U.S. Table of Allocations, either domestically or internationally; (ii) must immediately cease operations upon notification of interference resulting from the operations; and (iii) must accept any interference from any station authorized to operate at 11.7-12.2 GHz in compliance with spectrum allocations in the band. Boeing understands that the minutes to the 14th Plenary of WRC-03 (not yet available) include a similar statement recognizing this use of downlink spectrum for the international AMSS uplink allocation on the basis of No. 4.4 of the international Radio Regulations.

11.7-12.2 GHz band will operate on a non-harmful interference basis vis-à-vis other users of the band.

Second, because AMSS downlinks operate in the well-understood interference environment of the 11.7-12.2 GHz FSS band, AES receivers must be designed to tolerate the "noise" generated by other operations in the band. Thus, AMSS downlinks can operate effectively on an unprotected basis.

Lastly, it is important to note that in many countries Ku-band FSS downlinks are allocated in spectrum other than the 11.7-12.2 GHz band. Because AMSS systems operate globally, AESs must be designed to receive across the full range of spectrum used internationally for FSS Ku-band downlink operations.[25] As described above, however, AMSS receive operations can be conducted on an unprotected, non-harmful interference basis. Thus, authorizing AMSS downlinks as a non-conforming use throughout internationally allocated FSS downlink spectrum provides AMSS systems with the flexibility necessary to operate within the United States and abroad, while at the same time fully protecting other authorized users of the band wherever they may be located.

[25] For example, although Boeing will limit downlink operations in the United States to the 11.7-12.2 GHz band, its AESs will are designed to receive transmissions throughout the entire 10.7-12.75 GHz band to facilitate operations outside the United States.

III. THE COMMISSION SHOULD AMEND PART 25 OF ITS RULES TO INCLUDE TECHNICAL, LICENSING AND SERVICE RULES FOR KU-BAND AMSS OPERATIONS

To promote the successful deployment of AMSS operations in the Ku-band in a timely manner, the Commission should act now to develop and adopt comprehensive technical, operational and licensing rules governing this new service. Accordingly, Boeing seeks the adoption of a limited number of changes and additions to Part 25 of the Commission's Rules to govern AMSS operations and to normalize the licensing of AESs in the Ku-band.

Much of the technical and regulatory work necessary to develop these rules has already been done by the Commission in the context of reviewing Boeing's prior transmit-receive AES applications and in participating in the formulation of Recommendation ITU-R M.1643.[26] The Recommendation provides a useful starting point for consideration of sharing rules for the protection of other services in the Ku-band.[27] Boeing has prepared draft rules for inclusion in Part 25 to assist the Commission in developing a regulatory regime for this new service.[28]

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[26] *See, e.g., Transmit-Receive Order.*

[27] The licensing conditions imposed by the Commission on Boeing's AMSS operations in the *Transmit-Receive Order* were based on U.S. input into the draft new Recommendation that ultimately became Recommendation ITU-R M.1643. *See id.* at ¶¶ 13-15, 19. Incorporating similar provisions of Recommendation ITU-R M.1643 into the Commission's AMSS licensing rules will capture the fundamental technical issues addressed in the *Transmit-Receive Order.*

[28] *See* Attachment 2.

A. Technical Requirements for Ku-Band AMSS Operations

1. Protection of FSS Networks in the 14-14.5 GHz Band

a. Off-Axis E.I.R.P. Values

Recommendation ITU-R M.1643 describes the essential technical requirements for the protection of FSS operations by AMSS operations in the 14-14.5 GHz band. Fundamentally, this Recommendation provides that AMSS systems should be designed, coordinated and operated in such a manner that the aggregate off-axis e.i.r.p. density levels produced by all co-frequency AESs are no greater than the interference levels that have been coordinated for the FSS satellite system being used.[29]

For Ku-band AESs communicating with FSS satellites relying on the Commission's 2-degree spacing rules rather than operator-to-operator coordination agreements, the starting point for protecting adjacent FSS networks is contained in 47 C.F.R. §§ 25.134(a)(1) (VSAT networks operating in the 12/14 GHz bands) and 25.209 (Antenna performance standards). These rules were promulgated to allow for blanket licensing of Ku-band VSAT networks while protecting satellite operations in a 2-degree spacing environment.[30]

Experience has shown that these rules can be simplified to allow for AMSS operations so long as the applicant can demonstrate (*e.g.*, through an adjustment in power levels) that it can

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[29] *See* Recommendation ITU-R M.1643 at Annex 1, Part A, Section 1.

[30] Specifying VSAT antenna input power and performance requirements serves two fundamental purposes. First, the combination of these factors defines the off-axis e.i.r.p. directed towards adjacent satellites on the uplink. Second, the antenna performance requirement defines the minimum permissible susceptibility to interference from adjacent satellites on the downlink. By limiting interference into adjacent satellites from VSAT transmissions, and protecting VSAT receivers from adjacent satellite downlink interference, large numbers of VSAT terminals can be deployed without operator-to-operator coordination in a 2-degree spacing environment.

satisfy the aggregate e.i.r.p. density levels for routinely processed VSAT terminals. Thus, rather than imposing separate antenna performance requirements and input power levels, AMSS licensing rules need only ensure that the aggregate e.i.r.p. spectral density of all co-frequency AES transmissions will not exceed the levels generated by a routinely authorized VSAT under Section 25.134(a)(1) of the Rules (*i.e.*, a maximum input power density of -14 dBW/4 kHz into an antenna with sidelobes specified in Section 25.209(a)(1)). Significantly, the Commission adopted a similar approach for blanket licensing of next-generation Ka-band networks, thereby affording Ka-band operators the flexibility to trade-off antenna performance and power without any adverse impact on adjacent satellite operators.[31] Unlike primary Ka-band FSS earth station operations, however, there is no need for the Commission to specify antenna performance requirements (which protect receive operations from interference caused by adjacent satellite downlinks) because AMSS receivers will operate on an unprotected basis in the 11.7-12.2 GHz band.[32]

In view of the maximum VSAT power and antenna gain requirements noted above, AES off-axis e.i.r.p. spectral density along the geostationary arc for co-polarized signals should not exceed the following values:

Angle off-axis	Maximum e.i.r.p. in any 4 kHz band
$1.0° \leq \theta \leq 7.0°$	$15 - 25 \log \theta$ dBW
$7.0° < \theta \leq 9.2°$	-6 dBW
$9.2° < \theta \leq 48°$	$18 - 25 \log \theta$ dBW
$\theta > 48°$	-24 dBW

[31] *See* 47 C.F.R. § 25.138(a) (off-axis e.i.r.p. limits in Ka-band blanket licensing rules).

[32] *See* 47 C.F.R. § 25.138(e) ("Protection of receive earth stations from adjacent satellite interference is based on either the antenna performance specified in §25.209 (a) and (b), or the actual receiving earth station antenna performance, if actual performance provides greater isolation from adjacent satellite interference.").

Like Ku-band VSAT operators, however, AMSS systems should have the flexibility to coordinate AES transmissions in excess of these e.i.r.p. values, subject to an additional technical showing and the rights of future Ku-band licensees to require compliant operations in certain circumstances.[33] In addition, as with its Ku-band and Ka-band earth station licensing rules, the Commission should not view the off-axis e.i.r.p values as absolute, but rather should permit minor variances to account for variations in antenna performance where such variances would not adversely affect adjacent satellite operators.[34]

For Ku-band AESs communicating with FSS satellites relying on operator-to-operator coordination to address adjacent satellite interference (*i.e.*, for international operations where 2-degree spacing may not be the norm and the Commission's Part 25 Rules do not necessarily apply), applicants should be able to demonstrate compliance with the AMSS licensing rules by obtaining a certification from their satellite providers that the aggregate off-axis e.i.r.p. density levels produced by all co-frequency AESs communicating with the relevant satellite will be no greater than the interference levels that have been accepted by adjacent satellite systems through the operator-to-operator coordination process. Again, such an approach is fully consistent with the relevant provisions of Recommendation ITU-R M.1643.[35]

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[33] *See* 47 C.F.R. § 25.134(b), (c). The Commission's Ka-band earth station blanket licensing rules contain similar provisions regarding the coordination of higher off-axis e.i.r.p. values. *See* 47 C.F.R. § 25.138(b), (c).

[34] *See* 47 C.F.R. § 25.209(a) (allowing a 10 percent or 3 dB exceedance in the required Ku-band antenna performance, whichever is less, for angles greater than 7.0 degrees); *see also* 47 C.F.R. § 25.138(a)(3) (allowing a 3 dB exceedance in the required Ka-band off-axis e.i.r.p. values for angles greater than 10 degrees).

[35] *See* Recommendation ITU-R M.1643 at Annex 1, Part A, Section 1.

b. Factors Affecting Off-Axis E.I.R.P. Levels

As reflected in Recommendation ITU-R M.1643, properly designed AMSS systems should accurately calculate and control the off-axis e.i.r.p. levels to protect adjacent satellites operating in the 14-14.5 GHz band. Accordingly, consistent with Annex 1 of the Recommendation, Ku-band AMSS applicants should account for the following factors that could vary the aggregate off-axis e.i.r.p. levels generated by an AES:

- **Mispointing of AES antennas** -- An AES must be able to track accurately a serving satellite. Accordingly, where applicable, at a minimum an AMSS system must account for effects caused by bias and latency of pointing systems, tracking error of closed loop tracking systems, misalignment between transmit and receive apertures for systems that use separate apertures, and misalignment between transmit and receive feeds for systems that use combined apertures.[36]

- **Variations in AES antenna patterns** -- Where applicable, at a minimum an AMSS system must account for effects caused by manufacturing tolerances, aging of the antenna and environmental effects. AMSS systems using certain types of AES antennas, such as phased arrays, should account for variation in antenna pattern with scan angles (elevation and azimuth). AMSS systems using phased arrays should also account for element phase error, amplitude error and failure rate.[37]

- **Variations in the transmit e.i.r.p. from AES** -- Where applicable, at a minimum an AMSS system must account for effects caused by measurement error, control error and latency for closed loop power control systems.[38]

Recommendation ITU-R M.1643 also contains certain provisions relating to AES design. Specifically, AESs should be self-monitoring and should a fault occur that can cause harmful

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[36] *Id.* at Annex 1, Part A, Section 2.1.

[37] *Id.* at Annex 1, Part A, Section 2.2.

[38] *Id.* at Annex 1, Part A, Section 2.3. Calculations of e.i.r.p. based on the signal received by the satellite should account for error sources and latency, and calculations of e.i.r.p. based on AES input power should account for measurement error and reporting latency. *Id.*

interference to FSS networks be detected, an AES should automatically mute its transmissions.[39] In addition, AESs that use closed loop tracking of the satellite signal should employ an algorithm that is resistant to capturing and tracking adjacent satellite signals; AESs should immediately inhibit transmission when they detect that unintended satellite tracking has happened or is about to happen.[40]

Moreover, AESs should be subject to monitoring and control by a ground-based Network Control and Monitoring Center ("NCMC") or equivalent facility. In this regard, AESs should be able to receive at least "enable transmission" and "disable transmission" commands from the NCMC, and should cease transmission immediately on receiving any "parameter change" command that may cause harmful interference during the change, until receipt of an "enable transmission" command from its NCMC. In addition, it should be possible for the NCMC to monitor the operation of an AES to determine if it is malfunctioning.[41]

These technical and operational guidelines, which essentially mirror and update those imposed by the Commission in the *Transmit-Receive Order*,[42] will permit AMSS systems to operate in the 14-14.5 GHz band without causing harmful interference to co-frequency FSS networks adjacent to the satellites being used to provide AMSS. Accordingly, these provisions can be incorporated into the Commission's AMSS licensing and service rules.

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[39] *Id.* at Annex 1, Part A, Section 5.

[40] *Id.* at Annex 1, Part A, Section 3.

[41] *Id.* at Annex 1, Part A, Section 4.

[42] The *Transmit-Receive Order,* includes a number of conditions that were based on the U.S. input to the ITU-R Study Group process that ultimately resulted in the approval of Recommendation ITU-R M.1643. *See Transmit-Receive Order* at ¶19.

2. AMSS Requirements for Sharing with Federal Government Systems in the 14-14.5 GHz Band

An AMSS licensee should not be permitted to begin operations in the 14-14.5 GHz band until it has successfully completed coordination with Federal Government systems operating in primary and secondary allocations through the National Telecommunications and Information Administration ("NTIA") Frequency Assignment Committee of the Interdepartment Radio Advisory Committee ("IRAC"). At present, existing Federal Government services include Radio Astronomy Services in the 14.47-14.5 GHz band, and Space Research Services (Tracking and Data Relay Satellite System or "TDRSS") in the 14-14.2 GHz band. Such coordination need not be completed as a condition of filing an acceptable AMSS application, but rather should be a condition of any Ku-band AMSS authorization that must be satisfied prior to the commencement of operations. In this way, these required coordination discussions would not necessarily delay the grant of AMSS authorizations.

a. Radio Astronomy Service

To avoid causing harmful interference to authorized domestic RAS stations when they are conducting observations in the 14.47-14.5 GHz band, AMSS operators should be required to control their in-band emissions from all AESs operating in line-of-sight of each RAS station to acceptable levels. The details of individual coordination agreements, including specific protection levels, will vary based on the characteristics of each RAS station and the AMSS system. For example, the coordination agreements may require AMSS operators to reduce AES signal power levels, add sharp filtering, cease transmissions, improve AES antenna performance, or other measures to protect RAS stations during periods of observations. However, to ensure that AMSS operators are not unnecessarily constrained when RAS stations are not observing in the 14.47-14.5 GHz band, where practicable RAS observatories should be required to provide

advance notice to AMSS operators regarding observation schedules similar to the rules currently in effect for other RAS-MSS sharing situations.[43]

b. Space Research Service

Similarly, to avoid causing harmful interference to SRS operations in the 13.4-14.2 GHz band, AMSS operators should be required to control the emissions from all AESs operating in line-of-sight of SRS earth stations. Again, specifics of the required coordination agreements will vary based on the characteristics of the individual SRS stations and the AMSS systems.

3. Protection of the Terrestrial Fixed Service Outside the United States

Because there are no allocations for terrestrial FS operations in the 14-14.5 GHz band in the United States or in any bordering countries, the "essential requirements" relating to this service in Recommendation ITU-R M.1643 should not be included in the Commission's Rules with respect to domestic operations.[44] However, AMSS providers operating in international airspace near territories with co-frequency FS operations should be required to protect such operations from harmful interference.

As AMSS providers will be operating within the constraints of a secondary allocation they will already be required to protect primary FS operations outside the United States from harmful interference.[45] Thus, as an AES approaches the airspace of a foreign country with co-frequency FS operations, an AMSS provider may protect the primary FS operations by using

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[43] *See* 47 C.F.R. § 25.213(a)(1)(vi).

[44] *See* Recommendation ITU-R M.1643 at Annex 1, Part B. These limits relate to the pfd and angles of arrival that would be obtained under free-space propagation conditions. *Id.*

[45] Although such a requirement is inherent in the secondary status of the AMSS allocation, it is underscored by new country footnotes Nos. 5.BB02, 5.BB03 and 5.BB04 in the International Table of Frequency Allocations.

techniques such as power control or frequency avoidance. Alternatively, the AMSS provider may be able to negotiate a different sharing arrangement as part of its licensing process in the foreign country. In either case, FS operations outside the United States would be protected from unacceptable interference.

B. Blanket Licensing of AMSS Earth Stations in the Ku-Band

Blanket licensing has been successfully used by the Commission for a number of satellite services,[46] and clearly is appropriate in the context of Ku-band AMSS operations. Blanket licensing is essential for the ultimate success of AMSS systems, which will employ large numbers of AESs operating on aircraft all over the world. Individual licensing of each AES would substantially delay service, significantly increase the costs of deployment and unnecessarily waste Commission and commercial resources.

The Commission has already accepted a blanket licensing approach in the *Transmit-Receive Order*, authorizing Boeing to operate up to 800 technically identical AESs.[47] Furthermore, the proposed technical and operational requirements for Ku-band AMSS licensing specifically contemplate the operation of large numbers of AESs. Through compliance with the proposed rules, the Commission can be assured that blanket licensing of AMSS terminals will not cause harmful interference to other services operating in the Ku-band. Thus, the Commission should adopt rules to formalize the authorization of Ku-band AESs on a blanket-licensed basis.

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[46] *See, e.g.*, 47 C.F.R. § 25.135 (Little LEO MSS); 47 C.F.R. § 25.136 (L-band and Big LEO MSS); 47 C.F.R. § 25.138 (Ka-band GSO FSS); (*Declaratory Order in the Matter of Routine Licensing of Large Networks of Small Antenna Earth Stations Operating in the 6 GHz and 14 GHz Bands*, 2 FCC Rcd. 2149 (1987) and 47 C.F.R. § 25.134 (Ku-band VSATs and C-band CSATs).

[47] *See generally Transmit-Receive Order.*

One important issue that should be clarified by the Commission is the authority of a foreign-licensed AES (*e.g.*, on a foreign-registered aircraft) associated with a U.S. AMSS licensee to operate within U.S. airspace.[48] Boeing proposes that such an AES be temporarily associated with and licensed to the U.S. AMSS licensee (or service vendor authorized by the operator) when the AES is operating within U.S. airspace. For this temporary period, the U.S.-licensed AMSS operator shall assume the same licensee responsibility for the AES as if the AES were regularly licensed to it. Such an approach is similar to the Commission's treatment of MSS transceivers designed to operate with U.S.-licensed systems,[49] and is appropriate in the context of transborder Ku-band AMSS operations given the global nature of the service. Furthermore, this approach ensures that foreign-licensed AESs will comply fully with the Commission's AMSS technical and operational rules while operating within U.S. airspace.

C. The Commission Should Authorize Ku-Band AMSS Licensees to Operate Pursuant to an ALSAT Designation

In view of the unique characteristics of Ku-band AMSS operations, the Commission should extend its "ALSAT" designation to permit Ku-band AMSS licensees to communicate with all U.S.-licensed Ku-band FSS satellites and foreign-licensed Ku-band satellites on the Permitted Space Station List.[50] Originally, "ALSAT" was an abbreviation for "all U.S.-licensed

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[48] For example, aircraft equipped with AESs operated by Boeing in Germany would require an authorization from the Regulierungsbehörde für Telekommunikation und Post ("RegTP," the German regulatory authority for telecommunications and postal services) similar to that required from the Commission to operate AESs in the United States.

[49] *See* 47 C.F.R. § 25.136(c); *see also Big LEO Report and Order*, 9 FCC Rcd. 5936, ¶ 208 (1995) ("[A] roaming user's transceiver operations would fall within the blanket license of the satellite operator or the service vendor."); *see also* 47 C.F.R. § 25.135(d).

[50] This action would not require a specific rule change, but rather would be effected by allowing a Ku-band AMSS licensee to obtain an "ALSAT" designation as an authorized point of communication on its AES license.

satellites." Under an ALSAT earth station license, an earth station operator providing FSS services in the conventional C- and Ku-bands could access any U.S.-licensed satellite without additional Commission action, provided that those communications fall within the same technical parameters and conditions established in the earth station license.[51] The *DISCO II First Reconsideration Order* expanded ALSAT earth station licenses to permit ALSAT-designated earth stations to access any satellite on the Permitted Space Station List.[52] Although AMSS falls outside of the services traditionally permitted to obtain an ALSAT designation as an authorized point of communication,[53] extending ALSAT authority to Ku-band AMSS licensees is entirely appropriate given the nature of Ku-band AMSS operations.

Importantly, Ku-band AMSS systems are specifically designed to operate with Ku-band FSS satellites in the well-defined interference environment of that service. As a result, Ku-band AMSS operations are compliant with the Commission's 2-degree spacing rules (*i.e.*, operate within the off-axis e.i.r.p. levels of a routinely authorized VSATs or other coordinated parameters), and thus do not have the potential to cause harmful interference to adjacent satellite operators. Moreover, comprehensive ITU-R technical studies over the last several years have definitively established the ability of Ku-band AMSS systems to protect primary FSS operations. The authorization of AMSS uplink operations on a secondary basis only, which must fully protect primary FSS systems, further reinforces the conclusion that AMSS licensees may be

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[51] *See Amendment of the Commission's Regulatory Policies to Allow Non-U.S. Licensed Space Stations to Provide Domestic and International Satellite Service in the United States, First Order on Reconsideration*, 15 FCC Rcd 7207, 7210-11 (1999) ("*DISCO II First Reconsideration Order*").

[52] *See id.* at 7215-16.

[53] *See id.* at n.19.

permitted to communicate with U.S. and foreign-licensed Ku-band satellite authorized to serve the United States without risk of interference to adjacent FSS satellites. As a result, there is no technical reason to prohibit Ku-band AMSS systems from operating pursuant to an ALSAT designation, so long as other Commission rules applicable to Ku-band AMSS operations are satisfied.

Extending the ALSAT authority to Ku-band AMSS licensees also would have important public interest benefits. For example, the ability to communicate with all U.S.-licensed Ku-band satellites and foreign-licensed satellites on the Permitted Space Station List would afford Ku-band AES operators significant operational flexibility in providing advanced broadband connectivity to aircraft passengers. In addition, the ability to utilize numerous FSS satellite capacity providers would enhance competition and reduce costs in providing these innovative new services. From the Commission's perspective, extending ALSAT authority would further the interests of administrative convenience and reduce unnecessary regulation of AMSS systems because the Commission would not be required to process an AES earth station modification application each and every time a Ku-band AMSS licensee sought to add an authorized satellite point of communication. It would also promote the flexible use of spectrum in a manner that would in no way increase the potential for interference to other authorized users of the band.

Accordingly, the Commission should extend its "ALSAT" designation in the context of AMSS licensing to permit Ku-band AES licensees to communicate with all U.S.-licensed Ku-band FSS satellites and foreign-licensed Ku-band satellites on the Permitted Space Station List.

IV. APPLICABILITY OF AMSS RULES TO DOMESTIC AND INTERNATIONAL OPERATIONS

The AMSS rules proposed by Boeing would apply to the operation of AESs on all aircraft (U.S. or foreign-registered) flying within U.S. airspace, including airspace above U.S.

territorial waters and U.S. territories and possessions, and would also apply to AESs on any U.S.-registered aircraft operating in international airspace, subject to the licensing authority of other administrations while the aircraft is flying within the airspace of a foreign country.

Authorizing the operations of transmit-receive Ku-band AESs aboard U.S.-registered aircraft flying outside the United States is fully consistent with the Commission's jurisdiction under the Communications Act of 1934, as amended, and with general principles of international law. Section 301(e) of the Communications Act, with a limited exception not relevant here, grants the Commission jurisdiction to license the operation of radio stations "upon any vessel or aircraft of the United States."[54] The Commission's jurisdiction over aircraft of the United States under Section 301(e) is in no way limited by the geographic location of the aircraft.

In addition to the plain language and legislative history of Section 301(e), this conclusion is consistent with longstanding Commission precedent involving the exercise of substantive jurisdiction over and licensing of satellite earth stations operating beyond the twelve-mile

[54] *See* 47 U.S.C. § 301(e). The limited exception, set forth in Section 303(t) of the Act, does not constrain the substantive jurisdiction of the Commission over radio stations aboard U.S. aircraft, but rather authorizes the Commission to enter into agreements with foreign governments by which it shall recognize radio station and operator licenses issued to foreign aircraft operators that utilize U.S.-registered aircraft. *See* 47 U.S.C. § 303(t). The Commission also has the explicit authority to license "any other mobile stations within the jurisdiction of the United States." 47 U.S.C. § 301(f).

territorial limit of the United States.[55] Similarly, in the non-satellite context, the Commission routinely authorizes radio equipment on U.S. aircraft for both domestic and international use.[56]

The licensing of AMSS operations aboard U.S. aircraft while in international airspace is also consistent with general principles of international law. In this connection, the Convention on International Civil Aviation ("Chicago Convention"), to which the United States is a Signatory, explicitly recognizes that "appropriate authorities" of the nation in which an aircraft is registered retain licensing authority over radio stations aboard that aircraft even when located above the territory of foreign nation, provided such aircraft's radio stations are operated in accordance with the regulations of that foreign nation.[57] Thus, the Commission plainly has jurisdiction to authorize Ku-band AESs operating on U.S.-registered aircraft flying outside the United States, and the Commission's AMSS rules clearly would apply to such operations.

V. PUBLIC INTEREST BENEFITS OF KU-BAND AMSS SYSTEMS

Adoption of the proposed AMSS secondary allocation and licensing and service rules will result in substantial public interest benefits to the U.S. flying public. Indeed, the

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[55] *E.g., AMSC Subsidiary Corp.*, 10 FCC Rcd. 10924 (1995) (granting modification of blanket earth station license for 200,000 mobile earth terminals to operate throughout the United States and in U.S. coastal waters up to 200 miles offshore, the service area of the associated U.S.-licensed MSS satellite); *Aeronautical Radio, Inc., et al., Petition for Waiver of 87.147 and 87.187 of the Commission's Rules*, 5 FCC Rcd. 3038 (1998) (granting a waiver of the Commission's rules to permit commercial airlines to operate aircraft earth stations internationally for communications using Inmarsat).

[56] *See* 47 C.F.R. Part 87; *see also Amendment of Parts 21 and 74 of the Commission's Rules with Regard to Licensing in the Multipoint Distribution Service and in the Instructional Television Fixed Service for the Gulf of Mexico, Notice of Proposed Rulemaking*, FCC 02-101 (released May 3, 2002) (proposing licensing of MDS and ITFS spectrum in the Gulf of Mexico).

[57] *See* Convention on International Civil Aviation (signed Dec. 7, 1944) ("*Chicago Convention*") at Art. 30 (Aircraft radio equipment). While Annex 10 to the *Chicago Convention* primarily relates to safety and non-public correspondence communications, Article 30 by its terms is not so limited.

International Bureau recently cited WRC-03's allocation of spectrum for "broadband-in-flight, which provides high-speed Internet access to airline passengers," as a principal success of the U.S. Delegation in expanding choices for U.S. consumers.[58]

The requested AMSS allocation and service rules will afford Ku-band AMSS licensees, such as Boeing, the regulatory certainty necessary to fully implement their systems and to provide a broad range of advanced broadband satellite services to passengers and crew members aboard commercial, corporate and U.S. government aircraft. This, in turn, would enhance competition and accelerate the benefits of this innovative new service to consumers in the United States and around the world.

As described in Boeing's various AES applications, commercial and corporate passengers will enjoy the convenience of such services as high-speed Internet access and interactive entertainment options, and crew members will obtain access to broadband capabilities that would enhance the efficiency of aircraft operations through real-time equipment and supply information, weather updates, security monitoring and other applications. U.S. government personnel and decision makers will have access to real-time broadband communications services aboard government aircraft, enabling them to communicate more effectively and make timely and informed decisions affecting national security, foreign policy and other important U.S. Government matters.[59]

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[58] FCC News Release, *International Bureau Reports on Success of the 2003 World Radiocommunication Conference* (rel. July 10, 2003).

[59] *See* Application of the Boeing Company for Blanket Authority to Operate up to Eight Hundred Technically Identical Transmit and Receive Mobile Earth Stations Aboard Aircraft in the 11.7-12.2 and 14.0-14.5 GHz Frequency Bands, File No. SES-LIC-20001204-02300 (filed Dec. 4, 2000, supplemented Jan. 10, 2001); *see also* Reflector Antenna AES Application.

The proposed rules also will permit more efficient use of the radio spectrum. As discussed herein, AMSS systems can operate in the 14-14.5 GHz uplink band and 11.7-12.2 GHz downlink band without causing harmful interference to other allocated services. Furthermore, the requested regulatory changes, which will facilitate the provision of innovative AMSS services, are consistent with the Commission's recent Spectrum Policy Task Force recommendations concerning increased flexibility in the use of spectrum.[60] Specifically, the requested allocation will facilitate the provision of new and innovative AMSS services in spectrum that generally has been reserved for traditional FSS usage. Additionally, the technical characteristics of AMSS operations and the secondary nature of the allocation will ensure that primary users of the band are protected from harmful interference, while other incumbent secondary users are fully accommodated.

Finally, the United States has been a leading proponent of Ku-band AMSS services and it can maintain its leadership position on such technology issues by promptly implementing the decisions reached at WRC-03 with respect to this important new service.

VI. CONCLUSION

For all of the foregoing reasons, Boeing respectfully requests that the Commission initiate a rulemaking proceeding promptly to amend the U.S. Table of Frequency Allocations to include a secondary AMSS allocation in the 14-14.5 GHz band, and to adopt licensing rules for Ku-band AMSS operations as set forth herein.

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[60] *See* Spectrum Policy Task Force Report, ET Docket 02-135 (Nov. 2002) at 15-22.

Respectfully submitted,

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RECOMMENDATION ITU-R M.1643*

Technical and operational requirements for aircraft earth stations of aeronautical mobile-satellite service including those using fixed-satellite service network transponders in the band 14-14.5 GHz (Earth-to-space)

(2003)

Summary

This Recommendation provides the technical and operational requirements for aircraft earth stations (AES) of aeronautical mobile-satellite service (AMSS), including those using SFS network transponders operating in the band 14-14.5 GHz (Earth-to-space), that should be used by administrations as a technical guideline for: establishing conformance requirements for AES and facilitating their licensing, for worldwide use.

The ITU Radiocommunication Assembly,

considering

a) that various technically and operationally different aeronautical mobile-satellite service (AMSS) networks have been designed to commence operation in the near future;

b) that these planned AMSS networks may provide access to a variety of broadband communication applications (Internet, email, internal corporate networks) to and from aircraft on a global basis;

c) that the aircraft earth station (AES) will operate on national and international airlines around the world;

d) that circulation of AES is usually a subject of a number of national and international rules and regulations including satisfactory conformance to a mutually agreed technical standard and operational requirements;

e) that there is a need for identifying the technical and operational requirements for the conformance testing of AES;

f) that the identification of technical and operational requirements for AES would provide a common technical basis for facilitating conformance testing of AES by various national and international authorities and the development of mutual recognition arrangements for conformance of AES;

g) that the technical and operational requirements need to achieve an acceptable balance between radio equipment complexity and the need for effective use of the radio-frequency,

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*NOTE - The Arab Group represented at RA-03, and Canada reserve their position on this Recommendation and are not ready to accept any repercussions with respect to WRC-03 Agenda Item 1.11.

considering also

a) that in the frequency band 14-14.5 GHz there are allocations to the FSS (Earth-to-space), radionavigation, fixed and mobile (except aeronautical mobile) services on a primary basis; that secondary services allocated in the band 14-14.5 GHz or in parts of the band include mobile-satellite (except aeronautical mobile-satellite) service (Earth-to-space), space research service, radio astronomy service, and radionavigation-satellite service;

b) that there is a requirement to fully protect all primary services and pre-existing systems of secondary services in the band 14-14.5 GHz;

c) that results of the studies conducted in accordance with Resolution 216 (Rev.WRC-2000) showed the feasibility of using the band 14-14.5 GHz by AMSS (Earth-to-space) on a secondary basis under certain conditions and arrangements[1];

d) that the identification by ITU-R of technical and operational requirements for AES operating in the band 14-14.5 GHz could assist administrations to prevent harmful and/or unacceptable interference to other services;

e) that technical and operational characteristics should be continuously and accurately measurable and controllable,

recommends

1 that the technical and operational requirements[1] for aircraft earth stations of AMSS networks operating in the band 14-14.5 GHz given in Annexes 1 and 2 be used by administrations as a guideline for:

a) establishing conformance requirements for AES;

b) facilitating AES operations.

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[1] The characteristics of the typical aircraft earth stations need to fulfil the requirements described in this Recommendation and, further, need to be within the envelope of those initially published in the International Frequency Information Circular (BR IFIC) relating to the corresponding FSS network. In the case that the characteristics are outside of the envelope of those in the initial publication, the required coordination of such an aircraft earth station needs to be effected in accordance with the current provisions of the Radio Regulations (RR) and a modified Rule of Procedure as contained in § 2 of the Rules of Procedure relating to RR No. 11.32, as appropriate.

Annex 1

Technical and operational requirements for AES of AMSS networks in the band 14-14.5 GHz (Earth-to-space)

Part A

Essential requirements related to the protection of FSS networks

1 AMSS networks should be coordinated and operated in such a manner that the aggregate off-axis e.i.r.p. levels produced by all co-frequency AES within AMSS networks are no greater than the interference levels that have been published and coordinated for the specific and/or typical earth station(s) pertaining to FSS networks where FSS transponders are used.

2 The design, coordination and operation of an AES should, at least, account for the following factors which could vary the aggregate off-axis e.i.r.p. levels generated by the AES:

2.1 mispointing of AES antennas. Where applicable, this includes, at least, effects caused by bias and latency of their pointing systems, tracking error of closed loop tracking systems, misalignment between transmit and receive apertures for systems that use separate apertures, and misalignment between transmit and receive feeds for systems that use combined apertures;

2.2 variations in the antenna pattern of AES. Where applicable, this includes, at least, effects caused by manufacturing tolerances, ageing of the antenna and environmental effects. AMSS networks using certain types of AES antennas, such as phased arrays, should account for variation in antenna pattern with scan angles (elevation and azimuth). Networks using phased arrays should also account for element phase error, amplitude error and failure rate;

2.3 variations in the transmit e.i.r.p. from AES. Where applicable, this includes, at least, effects caused by measurement error, control error and latency for closed loop power control systems. Network control and monitoring centres (NCMCs) that calculate the e.i.r.p. of AES based on the received signal need to take into account error sources and latency in this calculation. NCMCs that calculate the e.i.r.p. of AES based on input power must account for measurement error and reporting latency.

3 AES that use closed loop tracking of the satellite signal need to employ an algorithm that is resistant to capturing and tracking adjacent satellite signals. AES must immediately inhibit transmission when they detect that unintended satellite tracking has happened or is about to happen.

4 AES should be subject to the monitoring and control by an NCMC or equivalent facility. AES must be able to receive at least "enable transmission" and "disable transmission" commands from the NCMC. AES must automatically cease transmissions immediately on receiving any

"parameter change" command, which may cause harmful interference during the change, until it receives an "enable transmission" command from its NCMC. In addition, it should be possible for the NCMC to monitor the operation of an AES to determine if it is malfunctioning.

5 AES need also to be self-monitoring and, should a fault which can cause harmful interference to FSS networks be detected, the AES must automatically mute its transmissions.

Part B

Essential requirements related to the protection of the fixed service

In the 14-14.5 GHz frequency band as used by fixed service networks, within line-of-sight of the territory of an administration where fixed service networks are operating in this band, the maximum pfd produced at the surface of the Earth by emissions from a single AES, of an AMSS network should not exceed:

$-132 + 0.5 \cdot \theta$	dB(W/(m^2 · MHz))	for	$\theta \leq 40°$
-112	dB(W/(m^2 · MHz))	for	$40 < \theta \leq 90°$

where θ is the angle of arrival of the radio-frequency wave (degrees above the horizontal).

NOTE 1 – The aforementioned limits relate to the pfd and angles of arrival that would be obtained under free-space propagation conditions.

NOTE 2 – An e.i.r.p. mask can be derived from the aforementioned pfd mask by applying the method given in Annex 2 of this Recommendation. Simplification of the resulting e.i.r.p. mask could also be considered.

Part C

Essential requirements related to sharing with the radio astronomy service

In order to protect the radio astronomy in the band 14.47-14.5 GHz, AMSS earth stations should comply with both following measures:

AMSS channels in the 14.47-14.5 GHz band

– AMSS stations do not transmit in the 14.47-14.5 GHz band within line-of-sight of radio astronomy stations operating within this band;

or,

– if an AMSS operator intends to operate co-frequency within the visibility of the radio astronomy station, a specific agreement with the radio astronomy station will be needed to ensure that AMSS AES will meet the requirements of Recommendations ITU-R RA.769 and ITU-R RA.1513 within the 14.47-14.5 GHz band during observations. Where practicable, this may include advance information to AMSS operators regarding observation schedules.

AMSS channels in the 14-14.47 GHz band

All AES transmitters on channels in the 14-14.47 GHz band within line-of-sight of radio astronomy stations during radio astronomy observations have emissions in the band 14.47-14.5 GHz such that they meet the levels and percentage of data loss given in Recommendations ITU-R RA.769 and ITU-R RA.1513. Results from studies show that the

following AES pfd levels (dB(W/(m^2 · 150 kHz))) in the band 14.47-14.5 GHz are sufficient, with some margin, to meet the radio astronomy pfd levels in Recommendation ITU-R RA.769 and the percentage of data loss given in Recommendation ITU-R RA.1513, i.e.:

$-190 + 0.5 \cdot \theta$	dB(W/(m^2 · 150 kHz))	for	$\theta \leq 10°$
-185	dB(W/(m^2 · 150 kHz))	for	$10° < \theta \leq 90°$

where θ is the angle of arrival of the radio-frequency wave (degrees above the horizontal).

Such AES pfd levels in the band 14.47-14.5 GHz may be achieved by the AMSS operators through a combination of reduced AES signal power, sharp filtering, maintaining adequate frequency separation, or better AES antenna performance.

Part D

Essential requirements related to sharing with the space research service

Coordination agreements should be developed between AMSS and space research systems based on controlling the emissions levels of the AES in the frequency band used by the SRS systems, and, in severe cases, may require cessation of AES emissions on frequencies used by the SRS system when operating in the vicinity of the space research earth station. Specifics of the agreements will vary based on the characteristics of the individual SRS sites and the AMSS networks.

Annex 2

Derivation of a lower hemisphere e.i.r.p. mask from a pfd mask

In testing AMSS equipment to determine if it meets a given pfd mask, such as the one in Annex 1, Part B, it may be useful to determine an equivalent e.i.r.p. mask that can be used for testing purposes.

The pfd mask, pfd(θ) where θ is the angle of arrival (elevation angle) at the Earth's surface, can be used to mathematically determine an e.i.r.p. mask, e.i.r.p.(γ, H) where γ is the angle below the local horizontal plane and H is the altitude of the aircraft. This conversion proceeds in two steps. First, γ is converted to an equivalent angle of arrival, θ. Then the length of the propagation path for angle of arrival θ is determined and used to calculate the spreading loss for the path and the resulting e.i.r.p.

Step 1: Calculation of an angle of arrival in degrees, θ, from γ and H:

$$\theta = \arccos((R_e + H)\cos(\gamma)/R_e)$$

where:

θ: angle of arrival

R_e: earth radius (6 378 km)

H: altitude of the aircraft (km)

γ: angle below horizontal.

NOTE 1 – If the argument of the arccos function is greater than 1, the propagation path in the direction of the angle γ does not intersect the Earth. In this case, which occurs for values of γ of about 3.5° or less, a value for θ does not exist and so there is no defined value for the pfd mask.

Step 2: Calculation of the e.i.r.p. value from the defined pfd(θ):

$$d = (R_e^2 + (R_e + H)^2 - 2\,R_e(R_e + H)\cos(\gamma - \theta))^{1/2}$$

$$\text{e.i.r.p.}(\gamma, H) = \text{pfd}(\theta) + 10\log_{10}(4\,\pi\,d^2) + 60$$

where:

d: distance between the AES and the considered point on the Earth's surface (km)

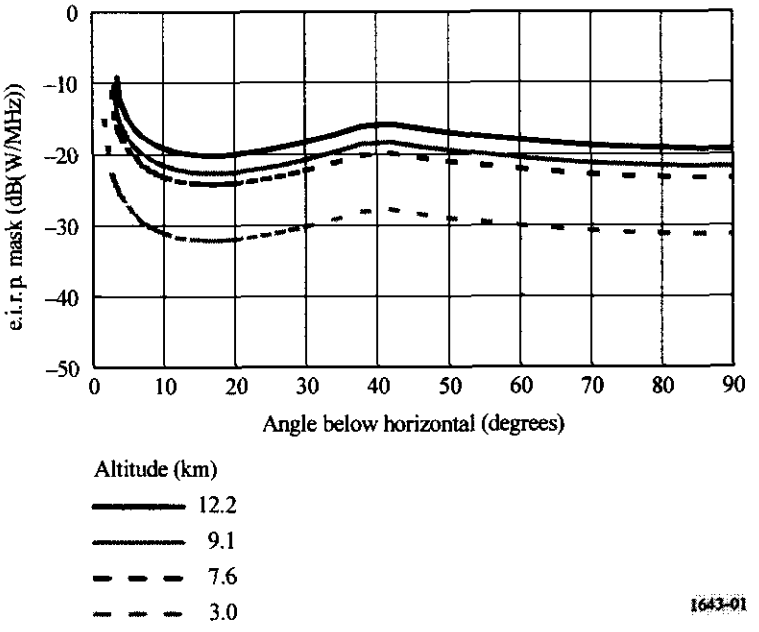
pfd(θ): (dB(W/(m^2 · MHz)))

e.i.r.p.: (dB(W/MHz)).

The graph in Fig. 1 shows this function for various aircraft altitudes based on the pfd mask provided in Annex 1, Part B of this Recommendation.

FIGURE 1

e.i.r.p. mask derived from pfd mask



New § 25.216

§25.216 Operating and licensing conditions for earth station networks in the 12/14 GHz aeronautical mobile-satellite service.

(a) Each applicant for a blanket aircraft earth station (AES) license in the 12/14 GHz aeronautical mobile-satellite service shall demonstrate that its AES transmissions will not cause unacceptable interference to authorized FSS networks operating in the 14.0-14.5 GHz band (Earth-to-space).

(1) For communications with FSS space stations that have not coordinated higher values with adjacent space stations, AES transmit off-axis EIRP spectral density along the GSO arc for co-polarized signals shall not exceed the following values:

Angle off-axis	Maximum EIRP in any 4 kHz band
$1.0° \leq \theta \leq 7.0°$	$15 - 25 \log \theta$ dBW
$7.0° < \theta \leq 9.2°$	-6 dBW
$9.2° < \theta \leq 48°$	$18 - 25 \log \theta$ dBW
$\theta > 48°$	-24 dBW

(2) The values given in paragraph (a)(1) of this section may be exceeded by 3 dB for values of $\theta > 10°$, provided that the total angular range over which this occurs does not exceed 20° when measured along both sides of the GSO arc.

(3) For communications with FSS space stations that have coordinated higher values with adjacent space stations, AES transmit off-axis EIRP spectral density along the GSO arc for co-polarized signals shall not exceed the values coordinated for the space station.

(4) Each applicant for AES license(s) that proposes transmit EIRP densities in excess of those specified in paragraphs (a)(1) and (a)(2) of this section shall submit link budget analyses of the operations proposed along with a detailed written explanation of how each uplink carrier density figure is derived. Applicants also shall submit a narrative summary which must indicate whether there are margin shortfalls in any of the current baseline services as a result of the addition of the applicant's high power service, and if so, how the applicant intends to resolve those margin shortfalls. Applicants shall certify that all potentially affected parties (i.e., those GSO FSS satellite networks that are 2, 4 and 6 degrees apart) acknowledge and do not object to the use of the applicant's higher power density.

(5) Licensees authorized pursuant to subparagraphs (a)(3) and (a)(4) of this section shall bear the burden of coordinating with any future applicants or licensees whose proposed compliant co-frequency operations, as defined by paragraph (a) of Section 25.134 and subparagraphs (a)(1) and (a)(2) of this section, is potentially or actually adversely affected by the operation of the non-compliant licensee. If no good faith agreement can be reached, however, the non-compliant licensee shall reduce its

power density levels to those compliant with subparagraphs (a)(1) and (a)(2) of this section.

(b) Each applicant for a blanket AES license in the 12/14 GHz aeronautical mobile-satellite service shall design and operate its network in accordance with the following requirements:

(1) AES networks shall account for the following factors, to the extent applicable, which could vary the aggregate off-axis EIRP levels generated by an AES:

(i) Mispointing of AES antennas. This includes, at a minimum, effects caused by bias and latency of pointing systems, tracking error of closed loop tracking systems, misalignment between transmit and receive apertures for systems that use separate apertures, and misalignment between transmit and receive feeds for systems that use combined apertures;

(ii) Variations in AES antenna patterns. This includes, at a minimum, effects caused by manufacturing tolerances, aging of the antenna and environmental effects. AMSS systems using certain types of AES antennas, such as phased arrays, should account for variation in antenna pattern with scan angles (elevation and azimuth). AMSS systems using phased arrays should also account for element phase error, amplitude error and failure rate;

(iii) Variations in the transmit EIRP from an AES. This includes, at a minimum, effects caused by measurement error, control error and latency for closed loop power control systems. Calculations of EIRP based on the signal received by the satellite should account for error sources and latency in this calculation, and calculations of EIRP based on AES input power should account for measurement error and reporting latency.

(2) AES networks shall:

(i) be self-monitoring, and shall automatically mute its transmissions in the event of a fault which can cause harmful interference to FSS networks;

(ii) if using closed loop tracking of the satellite signal, employ an algorithm that is resistant to capturing and tracking adjacent satellite signals, and immediately inhibit transmission in the event of unintended satellite tracking;

(iii) be subject to the monitoring and control by a ground-based Network Control and Monitoring Center (NCMC) or equivalent facility;

(iv) be able to receive at least "enable transmission" and "disable transmission" commands from the NCMC, and should cease transmission immediately on receiving any "parameter change" command which may cause harmful interference

during the change, until receipt of an "enable transmission" command from its NCMC; and

(v) be monitored by the NCMC in a way that permits the NCMC to determine if the AES is malfunctioning.

(c) Each aeronautical mobile-satellite service AES operator shall not commence operations in the 14.0-14.5 GHz band until such operations have been coordinated successfully with authorized U.S. Government stations through the National Telecommunications and Information Administration (NTIA) Frequency Assignment Committee of the Interdepartment Radio Advisory Committee (IRAC).

(1) AES operators shall avoid causing harmful interference to authorized U.S. Government radio astronomy stations during observations in the 14.47-14.5 GHz band, and shall control the in-band emissions levels of all AESs operating in line-of-sight of each radio astronomy station during such observations. To the extent practicable, U.S. Government radio astronomy stations shall provide advance information to AES operators regarding observation schedules. The protection of Very Long Baseline Array (VLBA) stations may require a different level of protection than other radio astronomy stations. The radio astronomy stations to be protected include:

Observatory	**Latitude** (DMS)	**Longitude** (DMS)
National Astronomy and Ionosphere Center (NAIC) site:		
Arecibo, PR	18 20 46	66 45 11
National Radio Astronomy Observatory (NRAO) sites:		
Green Bank Telescope, WV	38 25 59	79 50 24
Very Large Array, Socorro, NM	34 04 43	107 37 04
VLBA sites:		
St. Croix, VI	17 45 31	64 35 03
Hancock, NH	42 56 01	71 59 12
N. Liberty, IA	41 46 17	91 34 26
Ft. Davis, TX	30 38 06	103 56 39
Los Alamos, NM	35 46 30	106 14 42
Pie Town, NM	34 18 04	108 07 07
Kitt Peak, AZ	31 57 22	111 36 42
Owens Valley, CA	37 13 54	118 16 34
Brewster, WA	48 07 53	119 40 55
Mauna Kea, HI	19 48 16	155 27 29

(2) AES operators shall avoid causing harmful interference to authorized U.S. Government space research stations operating in the 13.4-14.2 GHz band.

(3) The details of individual coordination agreements, including specific protection levels, will vary based on the characteristics of U.S. Government station and the AES network. The coordination agreements may require AES operators to reduce AES signal power levels, add sharp filtering, cease transmissions, improve AES antenna performance, or implement other measures to protect U.S. Government operations.

(d) No AES associated with an authorized 12/14 GHz aeronautical mobile-satellite service operator shall transmit to a space station unless first authorized by the AES blanket licensee or by a service vendor authorized by that licensee, and the specific transmission is conducted in accordance with the operating protocol specified by the space station operator.

(e) Any non-U.S. licensed AES associated with an authorized 12/14 GHz aeronautical mobile-satellite service operator will be deemed, when communicating in U.S. airspace, to be temporarily associated with and licensed to the AES operator or service vendor holding a blanket earth station license awarded pursuant to this section. The U.S. AES licensee shall, for this temporary period, assume the same licensee responsibility for the AES as if the AES were regularly licensed to it.

(f) An AES applicant shall provide for each AES antenna type, a series of radiation patterns measured on a calibrated antenna range and, as a minimum, shall be made at the bottom, middle, and top frequencies of the 14.0-14.5 GHz band or, if the AES will operate only in a portion of the 14.0-14.5 GHz band, at the bottom, middle, and top frequencies of the sub-band in which the AES will operate. The radiation patterns should include:

(1) Co-polarized patterns for each of the two orthogonal senses of polarizations in two orthogonal planes of the antenna.

(i) In the azimuth plane, plus and minus 7 degrees and plus and minus 180 degrees.

(ii) In the elevation plane, zero to 45 degrees.

(2) Main beam gain.

(g) AES Ku-band receive antennas shall not be afforded protection from adjacent satellite interference or other co-frequency operations and AES receive operations will be authorized on an unprotected, non-harmful interference basis only. For purposes of monitoring receive antenna performance and susceptibility to interference, a 12/14 GHz aeronautical mobile-satellite service AES applicant shall provide, for each AES type, the

antenna performance plots specified in paragraph (f) for the 11.7-12.2 GHz band, as well as other bands in which the AES receiver is designed to operate.

(h) A 12/14 GHz aeronautical mobile-satellite service AES licensee applying to renew its license must include on FCC Form 312-R the number of AESs constructed at the time of renewal.

New § 25.132(h)

25.132 (h) This section shall not apply to 12/14 GHz aeronautical mobile-satellite service AES applicants seeking authority to operate pursuant to Section 25.216.